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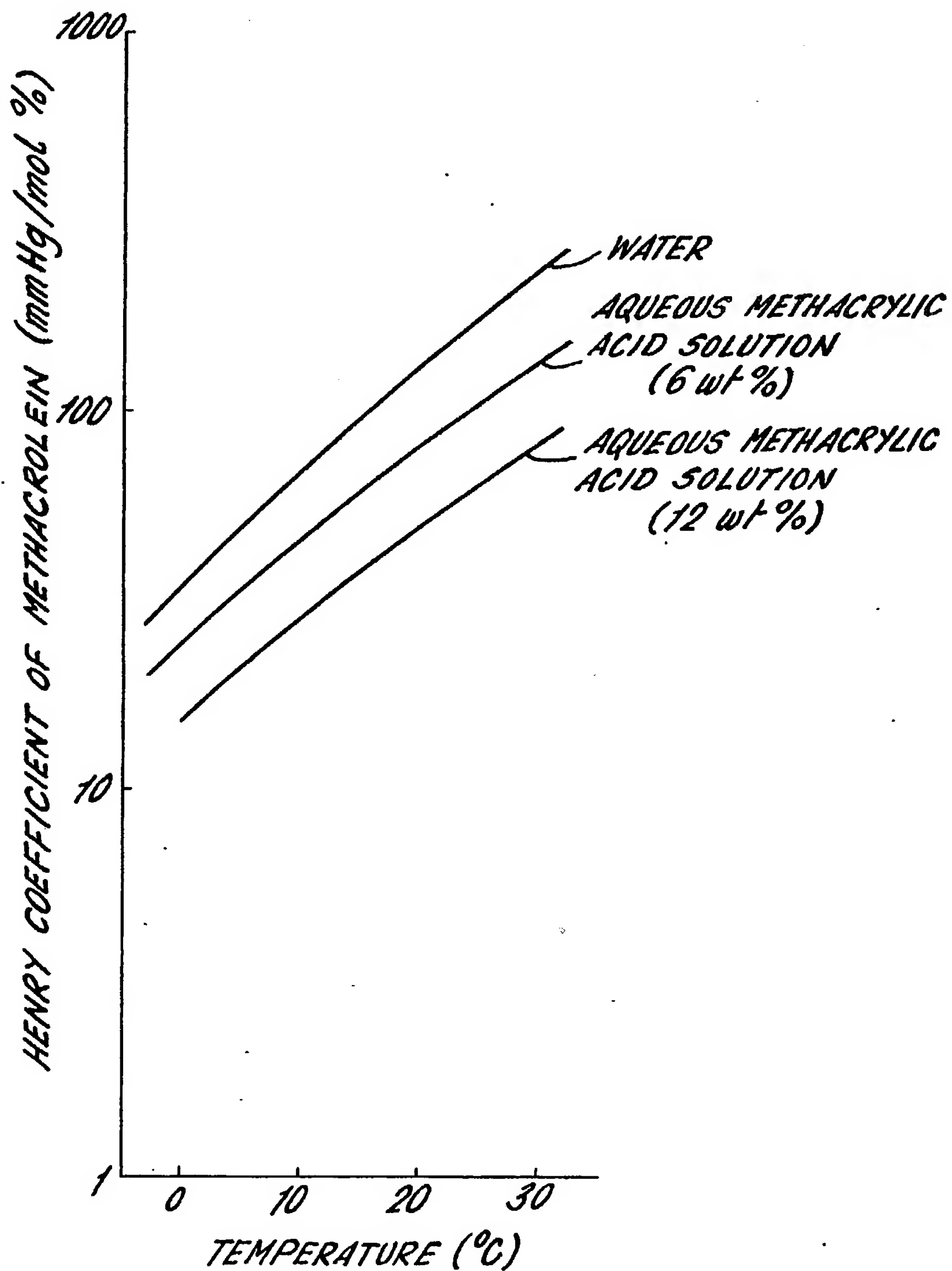
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(71) Applicants
Sumitomo Chemical
Company Limited, No. 15,
Kitahama 5-chome,
Higashi-ku, Osaka-shi,
Osaka, Japan
(72) Inventors
Tatsuya Ohnui
Michio Kato
Masami Ayano
Masaaki Iwasa
Tsunajiro Kawaguchi
(74) Agents
Boult, Wade & Tennant

(54) Separation of methacrolein
and/or methacrylic acid from a
gaseous mixture

(57) Methacrolein and methacrylic acid are separated from the gaseous reaction mixture obtained by catalytic oxidation of methacrolein or a methacrolein precursor by introducing the gaseous reaction mixture into a condenser wherein the reaction mixture is brought into direct countercurrent contact with condensed liquor previously obtained in the condenser to condense methacrylic acid and water vapour in the reaction mixture, introducing the gaseous residue into the bottom of a methacrolein-absorption tower wherein methacrolein in the gas is absorbed into an aqueous solution of methacrylic acid supplied to the top of the absorption tower, and sending the resulting methacrolein-containing, aqueous methacrylic acid solution obtained from the bottom of the tower to the top of a methacrolein-stripping tower while introducing the condensed liquor obtained by condensation of said gaseous reaction mixture into the middle part or top of the stripping tower wherein an inert gas is supplied to the bottom of the tower whereby methacrolein withdrawn from the top of the stripping tower and the aqueous methacrylic acid solution is withdrawn from the bottom.

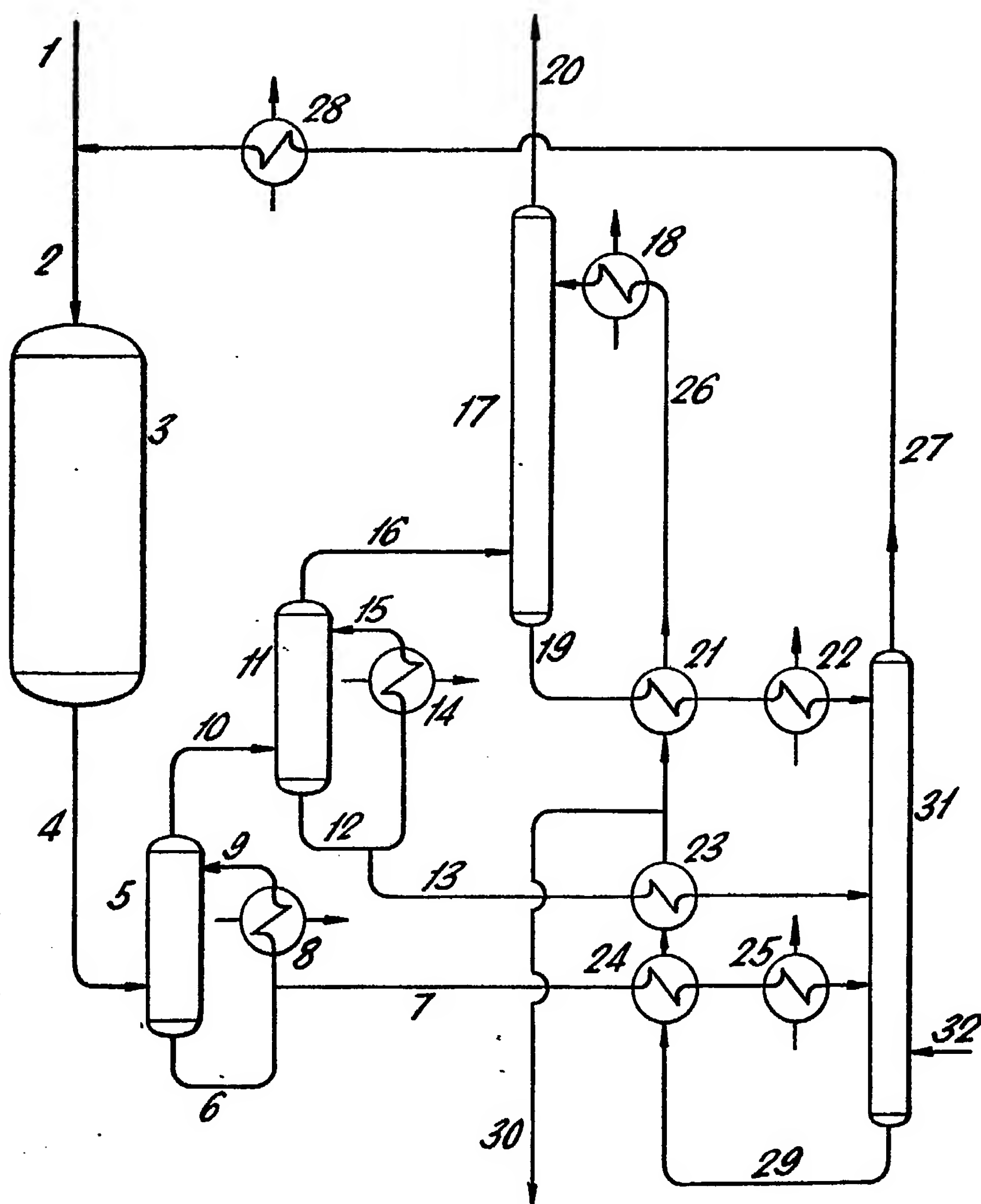
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FIG. 1.



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FIG. 2.



SPECIFICATION

Separation of methacrolein and/or methacrylic acid from a gaseous mixture

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The present invention relates to a process for the separation of methacrolein and/or methacrylic acid from a gaseous mixture containing them.

When methacrolein or a methacrolein precursor is oxidized in the gaseous phase together with water vapour and molecular oxygen (usually air) in the presence of an oxidation catalyst, a gaseous reaction mixture containing, in addition to methacrylic acid, acetic acid, carbon monoxide, carbon dioxide, unreacted methacrolein or the precursor oxygen and nitrogen is obtained. It is therefore necessary to recover not only methacrylic acid but also methacrolein from the reaction mixture. By the term "methacrolein precursor" as used herein is meant a compound which under suitable reaction conditions (e.g. catalytic oxidation) will yield methacrolein.

Examples of methacrolein precursors are isobutylene and tert-butanol.

Many commercial-grade catalysts for the oxidation of methacrolein or methacrolein precursors to methacrylic acid have been developed, but their performances are not yet satisfactory for commercial purposes. Particularly, at present, most of the catalysts have high selectivity to methacrylic acid under reaction conditions wherein the conversion of methacrolein is low, but the selectivity is very much lower under reaction conditions wherein the conversion is high. Consequently, when the conditions used are such that the conversion of methacrolein is relatively low, it is important to recover unreacted methacrolein efficiently from the aqueous methacrylic acid solution and to recycle the methacrolein to the oxidation reactor, in order to produce a process of overall commercial value.

A process for the separation of methacrolein from a gaseous reaction mixture is disclosed, for example, in Japanese Patent Publication (unexamined) No. 111,017/1975. A summary of this process is as follows: The methacrolein-containing gas mixture is absorbed in 50 to 500 moles of water per mole of methacrolein, and the resulting aqueous solution containing recovered methacrolein is then subjected to distillation or stripping to separate methacrolein.

In the absorption-separation of methacrolein from the gaseous reaction mixture by this process, it is necessary to carry out the absorption of methacrolein under high pressure or at low temperature, or with a large amount of water, or with an absorption tower having an extremely large number of trays, because the solubility of methacrolein in water is very low (6.1% by weight at 25°C). When a large amount of water is used as solvent for the absorption of methacrolein, not only the methacrolein-absorption tower but also the distillation tower and a stripping tower which follow the absorption tower need to be large. If the absorption of methacrolein is to be carried out under high pressure, the operating pressure of all the equipment including the reactor, which are ahead of the methacrolein-absorption tower, should be increased by an amount equal to

the operating pressure of the absorption tower. This results in operational difficulties because of pressure resistance and causes safety problems. The absorption of methacrolein at low temperature or with absorption towers having a large number of trays is also economically disadvantageous. Consequently, the use of solvents having a low methacrolein solubility of like water, is somewhat industrially unfavourable.

Because of the low solubility of methacrolein in water, using alcohols in place of water as a solvent for absorption of methacrolein is proposed in Japanese Patent Publication (unexamined) No. 92,007/1974. Alcohols are certainly effective for this purpose, but when the recovered methacrolein is recycled to the oxidation system, these organic solvents, although only present in trace amounts, cause difficulties such as catalyst poisoning, inhibition of oxidation, and abnormal reactions, for example, explosion by contamination with the vapour of the organic solvent. Accordingly, it is not always desirable to use organic solvents for the absorption of methacrolein for the simple reason that they absorb methacrolein very well.

As the result of extensive study to find a solvent for absorption of methacrolein which absorbs methacrolein very well and causes no problems such as catalyst poisoning even when recycled to the oxidation system together with recovered methacrolein, we have found that methacrolein has far greater solubility in aqueous methacrylic acid solution than in water, as shown in Fig. 1 of the accompanying drawings.

The invention provides a process for separating methacrolein and/or methacrylic acid from a methacrylic acid-containing gaseous mixture, which has been obtained by subjecting methacrolein or a methacrolein precursor to gas-phase catalytic oxidation, which process comprises introducing the gaseous mixture into a condenser maintained at a temperature not higher than 100°C to condense water vapour and methacrylic acid in the mixture and form a condensed liquor, absorbing methacrolein present in the gaseous residue in an aqueous methacrylic acid solution containing not less than 5% by weight methacrylic acid in an absorption tower at a temperature not higher than 30°C, the methacrylic acid solution and the gaseous mixture being supplied to the tower at a liquid to gas molar ratio of 8 or less, and passing the resulting methacrolein-containing methacrylic acid solution, the condensed liquor obtained in the condenser, and an inert gas, to a methacrolein stripping tower maintained at a temperature of from 30 to 100°C, the molar ratio of the total liquid to total gas supplied to the tower being from 3 to 30, and withdrawing methacrolein from the top of the stripping tower and aqueous methacrylic acid from the bottom of the stripping tower.

In the process for separating methacrolein and methacrylic acid from a reaction gas resulting from the gas-phase catalytic oxidation of methacrolein according to the present invention the gas mixture from an oxidation reactor wherein the gas-phase catalytic oxidation has been carried out is introduced into a condenser wherein the gas mixture is brought

into direct countercurrent contact, at 100°C or less, with condensed liquor previously obtained in the condenser, whereby water and methacrylic acid in the mixed gas are mainly condensed. When this
5 condensation is carried out in one step, the operating temperature is 100°C or less, preferably 30 to 80°C. While when the condensation is carried out in two steps, the operating temperature at the first step is 100°C or less, preferably 30 to 80°C, and that at the
10 second step is 10 to 50°C. In this case, the temperature at the second step is preferably not higher than that at the first step. Operating temperatures higher than 100°C are not desirable since they result in the polymerization of methacrolein and methacrylic
15 acid.

There is no particular limitation on the method to be used to bring the gas mixture into direct countercurrent contact with the condensed liquor and any conventional apparatus such as a packed tower, a
20 perforated plate tower, a bubble cap tower or a spray tower is suitable.

The methacrolein-containing gas from the top of the condenser is then introduced into the bottom of a methacrolein-absorption tower operated at a
25 temperature of 30°C or less, preferably 0 to 15°C. In the tower, the gas is brought into direct countercurrent contact with an aqueous solution containing 5% by weight or more, preferably 10% by weight or more, of methacrylic acid, the solution being supplied to the top of the tower, whereby methacrolein in the gas is absorbed in the solution. Thus, an almost methacrolein-free gas is obtained from the top, and an aqueous methacrylic acid solution containing absorbed methacrolein is obtained from the
35 bottom. In the methacrolein-absorption tower, operating temperatures of 30°C or more are not desirable since the efficiency of absorption of methacrolein becomes poor. Furthermore, concentrations of methacrylic acid of 5% by weight or less
40 are not desirable since the solubility of methacrolein becomes low and thus the absorption efficiency also becomes poor.

The type of the methacrolein-absorption tower is not particularly limited, and any tower of conventional type such as a packed tower, a perforated
45 plate tower, a bubble cap tower or a spray tower may be employed.

The aqueous methacrylic acid solution used for absorption of methacrolein is preferably used in an amount such that the molar ratio of the solution of the gas entering the absorption tower is 8 or less, preferably from 1 to 5. By the term "molar ratio" of liquid to gas as used herein is meant the molar ratio of all the constituents of the liquid to all the constituents of the gas.
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The absorbed methacrolein-containing, aqueous methacrylic acid solution from the bottom of the absorption tower is then introduced into the top of a methacrolein-stripping tower operated at 30 to
60 100°C, preferably at 50 to 80°C. The condensed liquor obtained in the condenser is introduced into the middle part or top of the said stripping tower. An inert gas such as nitrogen, air, carbon dioxide, exhaust gas resulting from the oxidation of methacrolein a methacrolein precursor, the gas mixture
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resulting from the combustion of such an exhaust gas or a mixture of two or more thereof is supplied to the bottom of the tower, and the amount of the gas supplied is made such that the molar ratio of the total liquor supplied to the tower to the gas is from 3 to 30, preferably from 5 to 20. Thus, methacrolein present in the aqueous solution and condensed liquor is separated therefrom and withdrawn from the top in the form of a gaseous mixture, and the aqueous methacrylic acid solution, almost freed from methacrolein is withdrawn from the bottom.

When the operating temperature of the methacrolein-stripping tower is 30°C or less, the vapour pressure of methacrolein becomes low so that stripping is not effective. When the temperature is 100°C or more, the polymerization of methacrolein and methacrylic acid becomes significant.
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There is no particular limitation on the type of stripping tower to be used, and any conventional tower of the gas/liquid contact type such as a packed tower, a perforated plate tower, a bubble cap tower or a spray tower may be used.
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The operating temperature of the absorption tower and the stripping tower may be maintained in various ways depending upon the type of tower. For example, a jacket or coil for a heating or cooling medium, as necessary, may be used.

The aqueous solution containing 5% by weight or more of methacrylic acid which is supplied, as a solvent for absorption of methacrolein, to the top of the methacrolein-absorption tower, may be obtained independently of this process, or may be bottom liquor from the methacrolein-stripping tower. In the latter case, the bottom liquor is cooled and recycled to the absorption tower.
100

The methacrolein-containing inert gas mixture from the top of the stripping tower may be used for the production of methacrolein or other purposes, or it may be recycled, together with an inert gas, to the reactor for gas-phase catalytic oxidation of methacrolein or a methacrolein precursor.
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The present invention will be illustrated in more detail with reference to the accompanying drawings wherein Fig. 1 is a diagram showing the Henry coefficients of methacrolein in water and in aqueous methacrylic acid solutions of two concentrations. Fig. 2 is a flow sheet showing in schematic form one embodiment of apparatus for separation of methacrolein and methacrylic acid according to the present invention.
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Referring first to Fig. 2, the gas mixture from a reactor 3 for the gas-phase catalytic oxidation of methacrolein or a methacrolein precursor is supplied to the bottom of a first condenser 5 through a line 4. The gas is there brought into direct countercurrent contact with methacrylic acid-containing liquor recycled through a line 6, a cooler 8 and a line 9, whereby methacrylic acid and water vapour in the mixed gas are condensed the methacrylic acid-containing liquor from the bottom of the first condenser 5 is supplied to the middle part of a methacrolein-stripping tower 31 through a line 7, a heat exchanger 24 and a heater 25. The top gas from the first condenser 5 is supplied, through a line 10, to the bottom of a second condenser 11 operated at a
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temperature lower than that of the first condenser 5. In condenser 11 the gas is brought into direct countercurrent contact with a methacrylic acid-containing liquor recycled through a line 12, a cooler 14 and a line 15, whereby most of the methacrylic acid and water vapour remaining in the top gas from the first condenser are condensed. The methacrylic acid-containing liquor from the bottom of the second condenser 11 is supplied to the middle part of the stripping tower 31 through a line 13 and a heat exchanger 23. The line 7 for withdrawing the first condensed liquor and the line 13 for withdrawing the second condensed liquor may separately be connected to the stripping tower 31 as shown in Fig. 2, or may be joined together and connected to the stripping tower 31.

The top gas from the second condenser 11, from which most of the methacrylic acid and water vapour have been removed in the first condenser 5 and the second condenser 11, is then supplied to the bottom of a methacrolein-absorption tower 17 through a line 16. An aqueous methacrylic acid solution is supplied to the top of the absorption tower 17 through a line 26 as a solvent for the absorption of methacrolein. The solution is brought into countercurrent contact with the ascending methacrolein-containing gas thereby absorbing methacrolein. The methacrolein-free top gas from the absorption tower 17 is withdrawn through a line 20 and discharged in air through an exhaust gas treatment zone. The aqueous methacrylic acid solution containing absorbed methacrolein is withdrawn through a line 19 and sent to the top of the stripping tower 31 through a heat exchanger 21 and a heater 22. It is desirable to operate the absorption tower 17 at as low a temperature as possible (e.g. 30°C or less, preferably from 0 to 15°C) in order to increase the amount of methacrolein absorbed. For this purpose, it is necessary to control the temperature by furnishing the tower with a jacket and/or a cooling coil in the tower and circulating a cooling medium therethrough. The aqueous methacrylic acid solution supplied through the line 26 may be circulation of some of the bottom liquor from the stripping tower 31, or may be an aqueous methacrylic acid solution obtained independently of this process.

An inert gas such as air, nitrogen, carbon dioxide, exhaust gas resulting from the oxidation of methacrolein a methacrolein precursor, or exhaust gas resulting from the combustion of such an exhaust gas is supplied to the stripping tower 31 through a line 32. Methacrolein is thus stripped from the liquors supplied through the lines 19, 13 and 7 and a methacrolein-containing gaseous mixture is withdrawn from the top through a line 27.

This gaseous mixture may be used for production of methacrolein or for other purposes, or may be recycled to the reactor 3 through a heater 28 and a gas feed line 1. The bottom liquor from the stripping tower 31 is passed through a line 29, cooled in heat exchangers 23 and 24 and withdrawn through a line 30 as an almost methacrolein-free, aqueous methacrylic acid solution. The solution may be further treated for the purification of the methacrylic acid or subjected to other treatment. Some of the bottom

liquor from the stripping tower 31 may be supplied to the absorption tower 17, as a solvent for the absorption of methacrolein, through a heat exchanger 21, a line 26 and a cooler 18.

In the methacrolein-stripping tower 31, the operating temperature drops since a large part of the methacrolein and some water are evaporated. It is therefore necessary to maintain the operating temperature within the required range as necessary by furnishing the tower with a jacket or a heating coil and circulating a heating medium therethrough. Incorporation of heat exchangers 21, 23 and 24, heaters 22 and 25, and a cooler 18 in the jacket system or the heating coil system of the absorption tower and the stripping tower does not always follow the flow sheet in Fig. 2, if the operating temperatures of the absorption tower and the stripping tower are kept within the required ranges. This equipment may be omitted or added additionally as required.

When condensation of the gas mixture is carried out not at two temperature-levels as in Fig. 2 but at one temperature-level, it is satisfactorily carried out by omitting the second condenser 11, the lines 12, 13, 15 and 16, the cooler 14 and the heat exchanger 23 and connecting the first condenser 5 directly to the absorption tower 17 through the top gas line 10.

In determining the operating temperature of the condenser, it is generally desirable that the temperature is such that usual cooling water can be used as a cooling medium for the coolers 8 and 14, which are attachments to the condenser. In addition to this, the lowest possible operating temperature is advantageous economically because this enables polymerization of methacrylic acid in the condensed liquor to be prevented and because it causes the amount of water vapour accompanying the top gas from the second (or first) condenser which is sent to the methacrolein-absorption tower 17 through the line 16 (or 10), to be minimised, and therefore the amount of cooling required at the absorption tower 17 and the cooler 18 can be decreased that much. However, too low an operating temperature is disadvantageous since the average temperature difference between the operating temperature and cooling medium becomes small so that a large heat transfer area is required to the coolers 8 and 14. Consequently, when a single condenser is used, the operating temperature is preferably from 30 to 80°C. When two condensers are used, it is desirable that the operating temperature of the first condenser is from 30 to 80°C and that of the second is from 10 to 50°C below the temperature range of the first one. Consequently, the selection of a one-condenser system, a two-condenser system or a system having more than two condensers has to be determined taking into account the required heat transfer areas of the coolers 8 and 14, attached to the respective condensers and the cooling load at the absorption tower and cooler 28. Consequently, the comparative merits of the various systems cannot be determined unconditionally.

The operating pressures in the condensers 5 and 11, methacrolein-absorption tower 17 and methacrolein-stripping tower 31 are determined in connection with the operating pressure in the reac-

tor 3. Preferably, however, these operating pressures are such that they can be reached without furnishing the line 16 or 27 with a compressor, and generally they are from 0 to 7 atg (gauge pressure), preferably from 0.5 to 4 atg.

The present invention will be illustrated with reference to the following examples, but it is not intended to limit the present invention thereto. In these examples, the numerals as referred to are those in Fig. 2 of the accompanying drawings.

Example 1

A gas mixture at 310°C containing 1.62% by volume of methacrolein, 1.57% by volume of methacrylic acid, 0.52% by volume of acetic acid, 42.75% by volume of steam and 53.53% by volume of non-condensable gases such as oxygen, nitrogen, carbon monoxide and carbon dioxide was supplied, at a rate of 4,528 NI/hr, to a porcelain, Raschig ring-packed tower as the first condenser. The temperature of the liquor condensed in the first condenser was 45 to 50°C, and the amount of the liquor produced was 1,698 g/hr. The concentrations of methacrylic acid, methacrolein and acetic acid in the liquor were 15.24% by weight, 0.18% by weight and 3.37% by weight, respectively.

The gas from the top of the first condenser 5 contained 2.65% by volume of methacrolein, 0.13% by volume of methacrylic acid and 8.08% by volume of steam, and 2,723 NI/hr (total volume) of the gas was supplied to a porcelain, Raschig ring-packed tower as the second condenser 11. The temperature of the liquor condensed in the second condenser was 32 to 35°C, and the amount of the liquor produced was 94.66 g/hr. The concentrations of methacrylic acid, methacrolein and acetic acid in the liquor were 10.19% by weight, 0.74% by weight and 4.567% by weight, respectively. The gas from the top of the second condenser 11 contained 2.75% by volume of methacrolein, 0.04% by volume of methacrylic acid and 4.62% by volume of steam, and 2,619 NI/hr (total volume) of the gas was supplied to the bottom of a stainless steel, Raschig ring-packed tower as the methacrolein-absorption tower 17. The molar ratio of liquid to gas supplied to the absorption tower was 2.59. As a solvent for absorption of methacrolein, a part of the bottom liquor (containing 15.1% by weight of methacrylic acid, 3.46% by weight of acetic acid and 0.20% by weight of methacrolein) from the methacrolein-stripping tower 31, was cooled to 8 to 10°C and supplied, at a rate of 6,378 g/hr, to the top of the absorption tower 17.

From the bottom of the absorption tower 17 was obtained 6,689 g/hr of a methacrolein-containing liquor, and the liquor contained 3.55% by weight of methacrolein, 14.46% by weight of methacrylic acid and 3.40% by weight of acetic acid. From the top of the absorption tower 17 was obtained 2,451 NI/hr of a gas containing 60 ppm of methacrolein. This methacrolein-absorption tower (diameter, 55 mm; height of packed portion 6 m) was equipped with a jacket and operated at 5 to 15°C. Both the first and second condensed liquors, and the absorbed methacrolein-containing liquor thus obtained were supplied to the middle part and top, respectively, of the methacrolein-stripping tower 31. To the bottom

of the stripping tower 31 was supplied 692 NI/hr of nitrogen gas the molar ratio of liquid to gas supplied to the stripping tower being 12.8, 847 NI/hr of a gas containing 8.48% by volume of stripped methacrolein and 10.0% by volume of steam was obtained from the top of the stripping tower. This gas was heated to 280°C and recycled to the oxidation reactor 3. From the bottom of the methacrolein-stripping tower 31 was obtained 8,183 g/hr of a bottom liquor containing 15.1% by weight of methacrylic acid, 3.46% by weight of acetic acid and 0.20% by weight of methacrolein. A part of the bottom liquor, 6,378 g/hr, was recycled as a solvent for absorption of methacrolein, and the rest, 1,805 g/hr, was withdrawn as a product. The stripping tower (diameter, 55mm; height of packed portion, 3m) was a stainless steel, Raschig ring-packed tower, and it was equipped with a jacket and operated at 60 to 70°C.

Example 2

Operation was carried out in completely the same manner as in Example 1 except that the second condenser 11 was omitted, the top gas from the first condenser 5 was directly supplied to the bottom of the methacrolein-absorption tower 17, and that the height of the packed portion in the tower 17 was changed to 6.5m. As a result, from the top of the absorption tower 17 was obtained a gas containing 65 ppm of methacrolein, and from the bottom of the tower was obtained 6,778 g/hr of a liquor containing 3.52% by weight of absorbed methacrolein, 14.41% by weight of methacrylic acid and 3.34% by weight of acetic acid. The compositions and flow amounts in other areas of this process were almost the same as in Example 1.

Although the invention has been described in terms of separation of methacrolein and/or methacrylic acid from gaseous mixtures, it should be understood that the invention in its broadest sense may be utilised to separate these compounds from an aqueous solution containing them.

CLAIMS

1. A process for separating methacrolein and/or methacrylic acid from a methacrylic acid-containing, gaseous reaction mixture obtained by subjecting methacrolein and/or a compound producing methacrolein under reaction conditions and molecular oxygen to gas-phase reaction at an elevated temperature in the presence of a catalyst for oxidation which comprises introducing the gaseous reaction mixture from a reactor wherein the gas-phase reaction has been effected into a condenser wherein the reaction mixture is brought into direct counter-current contact with a part of the condensed liquor previously obtained in the condenser at a temperature not higher than 100°C, whereby methacrylic acid and water vapour in the reaction mixture are condensed and a great part of methacrolein and non condensable gases are separated from the reaction mixture introducing the resulting gas into the bottom of a methacrolein-absorption tower operated at a temperature not higher than 30°C wherein methacrolein in the gas is absorbed, at a liquor to gas molar ratio of 8 or less, into an aqueous solution containing not less than 5% by weight of methacrylic acid supplied to the top of the absorption tower, and sending

the resulting methacrolein-containing, aqueous methacrylic acid solution obtained from the bottom of the tower to the top of a methacrolein-stripping tower operated at a temperature of 30 to 100°C while introducing the condensed liquor obtained by condensation of said gaseous reaction mixture into the middle part or top of the stripping tower wherein an inert gas such as nitrogen, air, carbon dioxide, exhaust gas, or mixed gas thereof, is supplied, at a liquor to gas molar ratio of 3 to 30, to the bottom of the tower whereby methacrolein in the methacrolein-containing, aqueous methacrylic acid solution or in the condensed liquors supplied is separated therefrom and withdrawn from the top and the aqueous methacrylic acid solution is withdrawn from the bottom.

2. A process according to Claim 1, wherein said direct countercurrent contact at 100°C or less between a part of the condensed liquor previously obtained in the condenser and the gaseous reaction mixture is carried out in one step or in plural steps.

3. A process according to Claim 1, wherein a part of the aqueous methacrylic acid solution from the bottom of the methacrolein-stripping tower is used as an absorption solvent for the methacrolein-absorption tower.

4. A process according to Claim 1, wherein the methacrolein-containing gaseous mixture from the top of the methacrolein-stripping tower is recycled to the inlet of the oxidation reactor.

5. A process for separating methacrolein and/or methacrylic acid from a methacrylic acid-contained gaseous mixture which has been obtained by subjecting methacrolein or a methacrolein precursor to gas-phase catalytic oxidation, which process introducing the gaseous mixture into a condenser maintained at a temperature not higher than 100°C to condense water vapour and methacrylic acid in the mixture and form a condensed liquor, absorbing methacrolein present in the gaseous residue in an aqueous methacrylic acid solution containing not less than 5% by weight methacrylic acid in an absorption tower at a temperature not higher than 30°C, the methacrylic acid solution and the gaseous mixture being supplied to the tower at a liquid to gas molar ratio of 8 or less, and passing the resulting methacrolein-containing methacrylic acid solution, the condensed liquor obtained in the condenser, and an inert gas, to a methacrolein stripping tower maintained at a temperature of from 30 to 100°C, the molar ratio of the total liquid to total gas supplied to the tower being from 3 to 30 and withdrawing methacrolein from the top of the stripping tower and aqueous methacrylic acid from the bottom of the stripping tower.

6. A process as Claimed in Claim 5, wherein a proportion of the condensed liquor produced in the condenser is recycled to provide a downward countercurrent flow of liquor in the condenser.

7. A process as claimed in Claim 5 or Claim 6, wherein the inert gas is nitrogen, and, carbon dioxide or exhaust gas resulting from the oxidation of methacrolein or a methacrolein precursor.

8. A process as claimed in any one of Claims 5 to 7, wherein the absorption of the methacrolein in the

said gaseous residue is carried out by countercurrent contact of the said gaseous residue with the said methacrylic acid solution in the absorption tower.

9. A process as claimed in any one of Claims 5 to 8, wherein gaseous residue from the condenser is introduced into a second condenser at a temperature of not higher than 100°C, to condense further quantities of water vapour and methacrylic acid in the mixture, and form a further quantity of condensed liquor.

10. A process as claimed in Claim 9, wherein the further quantity of condensed liquor is passed to the methacrolein stripping tower.

11. A process as claimed in Claim 9 or Claim 10, wherein a proportion of the further quantity of condensed liquor is recycled to provide a downward countercurrent flow of liquor in the second condenser.

12. A process as claimed in any one of Claims 9 to 11, wherein the second condenser is operated at a temperature of from 10°C to 50°C.

13. A process as claimed in any one of Claims 5 to 12, wherein methacrylic acid from the stripping tower is used as the said aqueous methacrylic acid solution containing not less than 5% by weight methacrylic acid, in the absorption tower.

14. A process as claimed in any one of Claims 5 to 13, wherein methacrolein from the stripping tower is used as feedstock to produce the said methacrylic acid-containing gaseous mixture by catalytic oxidation.

15. A process for separating methacrolein and/or methacrylic acid from a gaseous mixture, substantially as hereinbefore described with reference to Fig. 2 of the accompanying drawings.

16. A process for separating methacrolein and/or methacrylic acid from a gaseous mixture substantially as hereinbefore described in Example 1 or Example 2.

17. Methacrolein when obtained by a process disclaimed in any one of Claims 1 to 16.

18. Methacrylic acid when obtained by a process disclaimed in any one of Claims 1 to 16.

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